Welfare effects of rent control - A comparison of redistributive policies*

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Abstract

In the economic literature it is widely documented that price controls of the rental price of real estates have substantial distortive effects, which explains the common negative assessment of rent controls by economists. However, if policymakers aim at increasing welfare for the less wealthy in the economy, all policy options typically available have distortive effects. In this paper we compare the welfare effect of rent control to the most standard redistribution policy, an increase in tax financed transfers to the less wealthy. In a general equilibrium model calibrated to fit key characteristics of the German economy, we show that the introduction of rent control Pareto dominates tax financed transfer payments in steady state.

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1 Introduction

There seems to be a wide spread consensus among economists that controlling rents by setting an upper bound to rental prices, is not advisable. This critical view has been documented by Alston et al. (1992). According to their poll, 92.9% of economists agreed with the statement: "A ceiling on rents reduces the quantity and quality of housing available".[1] This has hardly changed in the last two decades. According to a poll conducted by the Initiative in Global Markets among leading economists in 2012, 81% of them disagreed with the statement that rent controls had a positive effect "on the amount and quality of broadly affordable rental housing in cities that have used them".[2] Only 2% of the economists in the survey agreed with this statement. Adjusted for the economists' confidence in their answer the picture becomes even more unanimous and the refusal of such a policy further increases.

This negative assessment of rent control is based on a substantial body of economic research. Rent control typically comes in hand with substantial distortions (Arnott 1995). If rent prices are set well below the undistorted equilibrium level, rationing of housing might be one consequence.[3] Distortions due to rent control include price distortions in uncontrolled housing (Frankena 1975; Fallis and Smith 1984; Fallis and Smith 1985; Hubert 1993), misallocation of renters (Glaeser 1996; Glaeser and Luttmer 2003), effects on housing quality (Frankena 1975; Albon and Stafford 1990), a decrease in tenant mobility (Clark and Heskin 1982; Ault et al. 1994) or an increase in tenancy duration (Nagy 1995; Munch and Svarer 2002).

Proponents of rent control, on the other hand, mostly emphasize the distributional benefit and argue that this outweighs allocative distortions (Gyourko and Linneman 1989). Tenants typically belong to the less wealthy part of an economy's population. Therefore various policies aim at increasing the welfare of tenants. One of such policies is to impose rent control. Ejarque and Kristensen (2013) e.g. show for Danish data that households living in housing subject to rent control have a lower expenditure share for housing than households living in unregulated housing. Arnott and Igarashi (2000) even show that rent control can increase search efficiency and this way might even be welfare improving. To summarize, given the different forms and aims of rent control the evaluation of its effectiveness is at best mixed (Turner et al. 1992; Arnott 2003).

[1] Of the 92.9% agreeing with the statement 16.6% did "agree with provisions", 76.3% "generally agree".

[2] The poll has been published on February 07, 2012. Initiative on Global Markets Economic Experts Panel represents the views of leading economists at the scientifically most influential universities in the United States. This way, their answers should represent the opinion of the "economic mainstream".

[3] Rationing of housing is not necessarily due to rent control. However, its effect typically is assessed to lead to substantial distortions. For effects due to rationing of housing not necessarily due to rent control, see e.g. Painter (1997) or Alexeev (1988).

Nevertheless, these redistributive effects seem to be the reason why rent control is still on the political agenda in many countries. A recent example is Germany, where the government elected in 2013 that announced the introduction of a new law that will enable federal states to introduce rent control by setting upper bounds to rent prices, even though the German rental market is already highly regulated (Börsch-Supan 1986). The new law on rent control is an addition to the second "Wohnraumkündigungsschutzgesetz" [Law for the Protection of Tenants from Arbitrary Eviction] which has taken effect in 1975. This law distinguishes between tenants that are staying in their home and those that relocate. It only limits price setting for tenants that stay in their home. For those tenants, rents should not be increased above the level of the average rent prices of comparable units. However, this law does not affect rent prices for newly negotiated contracts.

The draft of the new law aims at also restricting rent setting for these newly negotiated rent contracts. Rents for new tenants should not be allowed to exceed 110% of the average rent of comparable homes. Excluded from this regulation are newly build properties, which are supplied for the first time. However, this new regulation will not come into effect at the national level automatically. If the draft becomes a law, it will allow governments of the German states to apply the rent control in areas where substantial upward pressures on rents are visible.

An increase in the welfare of the less wealthy in the economy seems to be the main motivation for extending rent control in Germany. This is indicated by other measures that are part of the draft of the law, such as shifting fees for realtors which have been contracted by landlords from tenants to landlords. However, if the main argument for rent control is to increase tenants' welfare, it is important to compare the distortive effects of rent control to alternative redistributive policies. That is why we compare the welfare effects of the introduction of an upper bound to the rent prices with the most simple benchmark policy, an increase in government transfers to the less wealthy financed by an increase in the income tax rate.

We analyze these two policy options in a dynamic general equilibrium model of a closed economy similar to Iacoviello and Neri (2010). There are two types of households which share the same utility function but differ in their time preference. Impatient households have a relatively higher preference for current period utility in comparison to patient households. That is why they would like to dissave, but they are prohibited to do so by borrowing constraints. Due to their impatience they abstain from buying the durable good housing services and instead rent these from patient households. Due to the relatively lower preference for momentary utility, patient households will buy the durable good and end up owning the entire housing stock in the economy. That is why we interpret patient households to be the landlords, impatient households to be the tenants. We calibrate the model to fit key characteristics of the German economy.

Using this model we simulate two policies, an increase in the income tax rate to finance transfers to tenants and the introduction of rent control. This allows us first, to compare equilibrium allocation in steady state and second, to compare the transitional dynamics to the new steady state. We calibrate the size of the policy interventions to yield an identical steady state increase in the welfare of tenants. This way we show that the introduction of rent control has substantially less negative effects for the welfare of landlords. Rent control Pareto dominates an increase in tax financed transfer payments in steady state. However, the speed of convergence to the new steady state is substantially slower in the case of rent control.

The outline of the paper is as follows: In the next section we discuss the model. In section (3) we describe the model calibration, section (4) discusses the results of the simulation exercise, section (5) concludes.

2 Model

We consider a neoclassical closed economy general equilibrium model with a housing market. As differences in the time preference are an important driver of wealth dispersion (Guvenen 2011) we assume that households differ in terms of their valuation of future utility. Similar to Iacoviello and Neri (2010) and Ortega et al. (2011) there are two types of households, patient and impatient ones. Aside from these differences in time preferences, both types of households share the same utility function; they derive utility from consumption of consumption goods and housing services and dis-utility from working time.

Impatient households have a relatively higher preference for momentary utility and they would therefore prefer to accumulate debt. However, we assume the presence of borrowing constraints prohibiting indebtedness. This way, impatient households abstain from accumulating the durable good housing services and patient households end up owning the physical capital and rent out housing services to impatient households.[4] That is why we will refer to the two types as *landlords* (patient households) and *tenants* (impatient households).

As in Iacoviello and Neri (2010) and Ortega et al. (2011) we assume that the production sector produces two types of goods, consumption goods and housing services. Both goods differ in terms of their production technologies. As we are employing a comparison of different equilibria due to different forms of policy interventions we abstain from price

[4]For a detailed discussion see Section 2.1.

frictions and concentrate on the analysis of real variables.[5]

2.1 Households

There is total population P of households in the economy. The share ρ of total households is assumed to consist of landlords, the share $(1-\rho)$ is assumed to consist of tenants. i is an index identifying the individual household. **Landlords** maximize lifetime utility

$$E_0 \sum_{t=0}^{\infty} \beta^t U_{i,t} = E_0 \sum_{t=0}^{\infty} \beta^t (\ln(c_{i,t}) + \vartheta \ln(h_{i,t}) - \tfrac{\chi}{1+\eta}(n_{i,c,t} + n_{i,h,t})^{1+\eta}) \ , \tag{1}$$

which they derive from consumption of consumption goods $c_{i,t}$ and housing services $h_{i,t}$ less dis-utility from working. $n_{i,c,t}$ denotes working time in the sector for consumption goods, $n_{i,h,t}$ denotes working time in the sector that produces housing services. β is the landlords' discount factor. We assume that landlords own the entire stock of housing services ($H_t = \sum_i H_{i,t}$) and land ($L_t = \sum_i L_{i,t}$), allowing for a maximum living space of L_t square meters in the economy.[6] They face the budget constraint:

$$c_{i,t} + q_{H,t} I_{i,H,t} + \tfrac{b_{i,t}}{R_t} = (1-\tau_t)(w_{c,t} n_{i,c,t} + w_{h,t} n_{i,h,t} + q_{l,t} I_{i,l,t}) + b_{i,t-1} + m_t(H_{i,t} - h_{i,t}) \ . \tag{2}$$

In each period, landlords can use their income for consumption of goods and housing services, for investment in bonds $b_{i,t}$ at the price $\frac{1}{R_t}$, yielding a return of 1 in the next period, or for investment in housing services $I_{i,H,t}$. The latter are bought from firms in the construction sector at the price $q_{H,t}$. The income of landlords consists of labor income with the wage rate $w_{c,t}$ in the sector producing consumption goods, the wage rate $w_{h,t}$ in the construction sector and returns from land sales $I_{i,l,t}$ to firms in the construction sector at a price $q_{l,t}$. Additionally to that, landlords have returns from investment in bonds[7] and rent payments m_t from non-owner occupied housing services $(H_{i,t} - h_{i,t})$. Labor as well as income due to land sales are subject to the tax rate τ_t.

The stock of housing services follows the law of motion

[5] Typically the price level in general equilibrium models is not determined anyway.

[6] In Germany the government sets the floor space ratio restricting total living space of story proper on a given site. Given that the government also controls the total amount of land for building, this, de facto, results in the government's control over total living space available in the economy if land for building is a scarce good. One indication that this indeed is the case is the behavior of land prices that get declared as land for building. This typically coincides with a substantial price increases and indicates that land for building is a scarce good and the restriction of total living space is binding. This implies that our modeling assumption, the government controlling total living space in the economy, is a valid description of reality. That is why we interpret L_t as maximum amount of square meter living space in the economy.

[7] As landlords are the only ones with bond holdings in the economy, their net position is required to equal 0.

$$H_{i,t} = (1-\delta_H)H_{i,t-1} + I_{i,H,t} \tag{3}$$

with the housing specific exogenous depreciation rate δ_H. In modeling the process of depreciation we employ assumptions similar to the ones used in modeling sticky prices a la Calvo (1983). Each infinitely small unit of housing service H_t has the probability of depreciating δ_H, which is independent of the time of construction. In the event of depreciation, the land that has been used in the production process of this specific housing service is now newly available to the households to be sold to a construction firm. This way, land reenters the construction process. Assuming this setup allows us to ignore the potentially changing housing quality per unit of land, and, given the law of large numbers, each period the fraction δ_H of land in the economy becomes newly available to enter the production process.

As new land sales cannot exceed the land that is newly available due to depreciation of housing services this implies the additional constraint:

$$I_{i,l,t} \leq \delta_H L_{i,t-1} \ . \tag{4}$$

Tenants face the same utility function as landlords. However, they have a lower preference for future utility ($\beta^I < \beta$). An I in the superscript indicates that the variables belongs to a tenant.

$$E_0 \sum_{t=0}^{\infty} (\beta^I)^t U_{i,t}^I = E_0 \sum_{t=0}^{\infty} (\beta^I)^t (\ln(c_{i,t}^I) + \vartheta \ln(h_{i,t}^I) - \tfrac{\chi}{1+\eta}(n_{i,c,t}^I + n_{i,h,t}^I)^{1+\eta}) \ . \tag{5}$$

Tenants have expenditures for consumption $c_{i,t}^I$ and rent payments for housing services $m_t h_{i,t}^I$. Similar to landlords their labor income ($w_{c,t}^I n_{i,c,t}^I + w_{h,t}^I n_{i,h,t}^I$) is subject to taxation. We abstract from a progressive tax scheme and assume a flat tax rate for all households in the economy, which is given by τ_t. In the baseline scenario, tenants receive government transfers $\phi_i(Y_t + q_{H,t} I_{H,t})$. Y_t refers to the production of consumption goods in period t with consumption goods being the numeraire in the economy, $I_{H,t} = \sum_i I_{i,H,t}$ represents aggregate investment in housing services. The parameter $\phi_{i,t}$ indicates that transfers to individual tenants are a fraction of total production in the economy.[8] Tenants maximize utility subject to the budget constraint (6) and the borrowing constraint (7).

$$c_{i,t}^I + m_t h_{i,t}^I + \tfrac{b_{i,t}^I}{R_t} = (1-\tau_t)(w_{c,t}^I n_{i,c,t}^I + w_{h,t}^I n_{i,h,t}^I) + \phi_i(Y_t + q_{H,t} I_{H,t}) + b_{i,t-1}^I \tag{6}$$

[8] Aggregation over all households yields the total share of redistributed production as $\phi = \sum_i \phi_i$.

$$0 \leq \frac{b^I_{i,t}}{R_t} \tag{7}$$

Given tenants' relatively higher preference for momentary utility, they would like to dissave to finance current period's consumption. However, assuming the existence of a stable equilibrium, the borrowing constraint (7) does bind and prohibits the accumulation of debt.[9] This shows that tenants are in favor of utilizing their resources to extract utility instead of saving for future periods and end up saving as little as possible in steady state.[10] Transferring this to the tenants' decision on renting or buying durable goods such as housing services, this implies that an additional equation prohibiting short sales of housing services would be binding in equilibrium and landlords will end up owning the housing stock.[11]

2.2 Production

There are two types of goods, consumption goods Y_t and housing services I_t, which differ in terms of their production technology. Both goods are produced by perfectly competitive firms, maximizing profits d_t. Firms producing consumption goods maximize profits

$$d_{c,t} = Y_t - w_{c,t} n_{c,t} - w^I_{c,t} n^I_{c,t} \tag{8}$$

subject to the production technology

$$Y_t = n^{\alpha}_{c,t} (n^I_{c,t})^{1-\alpha} \ . \tag{9}$$

Firms producing housing services maximize dividends

$$d_{h,t} = q_{H,t} I_{H,t} - w_{h,t} n_{h,t} - w^I_{h,t} n^I_{h,t} - q_{l,t} I_{lt} \tag{10}$$

subject to the production technology

[9] In the steady state the Euler equation of landlords reduces to $1 = R\beta$ while the tenant's consumption-savings decision is characterized by $1 = R\beta^I + \frac{\lambda^I_B}{c^I}$, with λ^I_B the Lagrange multiplier for the borrowing constraint (7). Solving for λ^I_B we get $\lambda^I_B = (1 - \frac{\beta^I}{\beta})c^I$ which is positive, and implies that the borrowing constraint is binding in equilibrium.

[10] Assuming the borrowing constraint for tenants would not be binding, the Euler equation for landlords is given by $\beta \frac{c_{i,t}}{c_{i,t+1}} R_t = 1$, the one for tenants reads $\beta^I \frac{c^I_{i,t}}{c^I_{i,t+1}} R_t = 1$. As $\beta > \beta^I$ this implies that there only exists a steady state if the borrowing constraint for tenants is binding. Even if tenants own a substantial share of the capital stock, the difference in the discount factor would result in tenants increasing consumption compared to their steady state level till the borrowing constraint is binding.

[11] For this reason we abstain from allowing tenants to accumulate housing stock. (Iacoviello and Neri 2010) employs a similar assumption with respect to their treatment of capital.

$$I_{H,t} = (n_{h,t}^{\alpha}\ (n_{h,t}^{I})^{1-\alpha})^{1-\mu_l}\ I_{l,t}^{\mu_l}\ . \tag{11}$$

$n_j = \sum_i n_{i,j}$ and $n_j^I = \sum_i n_{i,j}^I$ for $j \in \{c, h\}$ represent aggregate labor input of the two household types in the two sectors. As in (Ortega et al. 2011), which simulate the welfare effects of a removal of the subsidy to housing purchases and the introduction of a subsidy to rentals in the Spanish economy, we abstract from physical capital in the production process.[12] For consumption goods the only input factor is labor. For the sector producing housing services, which might be thought of as the construction sector, there are two input factors in the production process. These are labor as well as land with the latter being bought from landlords.

As we do not have a strong prejudice about the productivity of the two different types of households and the differences in the savings behavior and the accumulation of durables stem from differences in the discount factor, we assume that labor income for the individual households is similar and independent of the household type. This implies that the labor share of the two household types α is similar to the population share ρ, which seems to be a common assumption in heterogeneous agent models and has also been implemented by Iacoviello and Neri (2010).[13]

The main focus of this paper is to analyze steady state effects of a policy intervention in the housing market. We abstract from monopolistic competition in the production sector.[14] As monopolistic competition and resulting price frictions due to sticky prices typically are assumed not to have an effect on steady state allocation the assumption of perfect competition should not affect the validity of the results.[15]

2.3 Equilibrium

The government does not have access to lump-sum taxation but to distortionary taxation of income only. It balances the budget by adjusting the tax rate to fund public spending. Public spending consists of two types; both are assumed to be a fixed proportion of total production in the economy. On the one hand there is the fraction θ of total production

[12]This simplification is equivalent to the assumption that the stock of physical capital in the economy is time invariant and it is not affected by any government policy we simulate. Similar assumptions are made in the business cycle literature, as the New Keynesian Model abstracts form adjustments in investment activity given the economy is hit by a shock. However, one should be aware of this simplifying assumption employed in this model.

[13]In section (4.3) we abolish the assumption of the labor share being equal to the population share, which should serve as a robustness check. Instead, we assume that the 43% of the population that own real estate are the ones with the highest labor income.

[14]Due to this assumption firms are not able to generate any profits ($d = 0$).

[15]Steady state distortions of monopolistic competition are typically assumed to be offset by government transfers to the production sector.

that represents spending that is required to keep the public sector in operation. This includes e.g. expenses for the legal system but also social security, where employees' contributions are at least in principle linked to payments in the occurrence of an insured event. On the other hand there are transfer payments. In the baseline scenario these are assumed to sum up to the fraction ϕ of total production. The tax rate τ_t adjusts to satisfy the government's budget constraint

$$\tau_t(w_{c,t}n_{c,t} + w^I_{c,t}n^I_{c,t} + w_{h,t}n_{h,t} + w^I_{h,t}n^I_{h,t} + q_{l,t}I_{l,t}) = (\theta + \phi)(Y_t + q_{H,t}I_{H,t})\,. \qquad (12)$$

Total housing services H_t are given by the sum of the housing services consumed by the two types of households. h_t and h^I_t result from aggregation of individual households' consumption of housing services $h_t = \sum_i h_{i,t}$ and $h^I_t = \sum_i h^I_{i,t}$

$$H_t = h_t + h^I_t\,. \qquad (13)$$

As discussed, land for building determines total living space in the economy and is assumed to be exogenous. We assume living space in the economy to be constant over time.[16]

$$L_t = L_{t-1} \qquad (14)$$

2.4 Policy Simulation

Let us now assume the government has the aim of reducing the differences in welfare between the more wealthy landlords and the less wealthy tenants. As already laid out, we assume that the government is not able to increase total living space in the economy and it does not have access to lump sum taxation. Both of these policies would have minor distortionary effects as they do not have an effect on the households' behavioral equations and affects the equilibrium due to the change in net wealth only. On the other hand, these assumptions seem plausible as lump sum taxation is not in the toolkit of economic policies and governments do not increase living space in the economy in a way that would eliminate the premium for land for building in comparison to wasteland. Hence, we consider two other polices. First, an increase in transfer payments to renters that is proportional to total output in the economy. These additional benefits are financed by an increase in the

[16]Given this model setup an increase in the land available for new building is the most efficient way to increase welfare in the economy as there are no drawbacks associated with such a policy. However, in reality a reclassification of waste land to land for building has drawbacks such as potentially substantial government investment for site development or it might not even be possible due to geographical constraints.

income tax rate. Second, we consider the introduction of rent control.

2.4.1 Redistribution

Let us first consider the baseline policy, an increase in transfers to tenants. Instead of the proportion ϕ we assume the government now redistributes the fraction $\phi + \varsigma_t$ of total production $Y_t + q_{H,t} I_{H,t}$. Such a policy might be thought of as a lump sum transfers, as the individual's contribution to total production is negligible and this way the introduction of such a transfer scheme does not distort the households' behavioral equations and hence, his decision on the allocation of resources. That is why, the policy simulation might be thought of as an upper bound for the effectiveness of such a policy. In reality, the process of redistributing resources to the less wealthy most likely is associated with additional inefficiencies lowering the effectiveness of such a policy. To finance this redistribution, the government increases the distortionary tax rate τ_t. The government's budget constraint in such a case is then given by

$$\tau_t(w_{c,t}n_{c,t} + w^I_{c,t}n^I_{c,t} + w_{h,t}n_{h,t} + w^I_{h,t}n^I_{h,t} + q_{l,t}I_{l,t}) = (\theta + \phi + \varsigma_t)(Y_t + q_{H,t}I_{H,t}) \, . \tag{15}$$

Given the introduction of lump sum transfers tenants receive the additional fraction ς_t of total production as additional income. This alters the aggregate budget constraint for tenants to

$$c^I_t + m_t h^I_t = (1 - \tau_t)(w^I_{c,t}n^I_{c,t} + w^I_{h,t}n^I_{h,t}) + (\phi + \varsigma_t)(Y_t + q_{H,t}I_{H,t}) \, . \tag{16}$$

2.4.2 Rent Control

As an alternative, we assume the government passes legislation restricting price determination in the rental market for housing services. We consider the case of real square meter rents $m_t \frac{H_t}{L_t}$ being linked to real square meter prices of newly build homes $q_{H,t} \frac{I_{H,t}}{I_{l,t}}$. With this formulation of rent control we slightly deviate from the conventional practice. If governments introduce rent control, they typically set an upper bound for rent prices or for price increases. As the price level in general equilibrium models is typically not determined, setting an upper bound in nominal terms is not sufficient to pin down an equilibrium.[17] That is why we decide to link real rental prices to the real price of a newly built homes, manipulating the price-to-rent ratio. Even though this does not seem to be the standard approach, the price-to-rent ratio is an important variable for all participants in the real estate market and this way one possible variable for a policy intervention. As

[17]Indeterminacy of the price level is the reason why we stick to a real model.

we do not explicitly model the process that results in equation (17) holding with equality, one might think of tenants being able to challenge any of the landlords' rent claims, if these would result in a violation of equation (17). This seems to be in line with the practice of rents for sitting tenants, who can challenge any rent increase, if such an increase would result in the individual rent being above the average rent of comparable objects.

Rewriting the square meter rent and price yields the following equation, which extends the landlords maximization problem by an additional condition:

$$m_t H_t \leq q_{H,t} I_{H,t} \frac{\gamma_H}{\delta_H} \ . \tag{17}$$

In equation (17) we assume the government is able to set γ_H. As we assume the government sets the relation in a way that the fraction of rents to prices becomes smaller than the equilibrium value without government intervention, equation (17) will hold with equality.

The additional equation in the landlords' maximization problem has two effects. First, it affects the landlords' decision on the optimal housing stock H_i. Second, it affects the landlords decision on the amount of housing investment $I_{i,H}$. In section (4) we show how this affects the equilibrium allocation in the model.

3 Calibration

While the comparison of different redistributive policies is in general interesting, due to the recent policy proposal to implement additional rent control, this has become an especially important topic in Germany. Therefore, we calibrate our model to replicate key features of the German economy and the real estate market.[18] There are nine parameters in the baseline model: $\beta, \alpha, \rho, \eta, \mu_l, \delta_H, \vartheta, \chi, \theta$.[19] Additionally to that, there are two equilibrium values that are exogenous in the model. These are total living space in the economy L and total population P. An overview of the calibration is reported in table (1) in appendix B.

Total living space we set to 3.346, representing an average living space of 3.346 Bil. square meters in the years 2006 and 2007. Total population P is set to 0.08, representing a total population of 80 Mil residents.

We set the time preference for landlords to $\beta = 0.9925$, implying an annual steady

[18]As real estate related data in Germany are mostly available on annual basis and e.g. total base area is only available for the years of 2004 and 2008 – 2011 we refrain from estimating the model and stick to calibration.

[19]Given the restriction $\beta^I \leq \beta$ (footnote 9) the tenants' maximization problem becomes static and the parameter β^I neither impacts equilibrium determinacy nor the dynamics in the model and this way does not have to be calibrated.

state real interest rate of 3%.[20] The parameter $\eta = 2$ implies a Frisch elasticity of labor supply of 0.5. We use the parameter χ, the relative weight of dis-utility from working-time, to set total hours worked in the economy $(n_c + n_c^I + n_h + n_h^I)$ to 14.25 in the baseline scenario. This represents an average of 57 billion hours worked per year in the years from 1991 − 2011.

Turning to the housing market specific parameters we set ρ, the share of home owners in the economy, to 0.43. This has been the average share of households owning real estate in the years from 1998 − 2010.[21] As we assume the labor share of the individual household to be identical across the two household types, in the baseline calibration we assume the labor share of the two types is a mirror image of the relative population shares ($\alpha = \rho$).[22] The depreciation rate of residential real estate δ_H is set to 0.0075 implying an annual depreciation rate for residential real estate of about 3%. This parameter choice implies an average life expectancy of about 70 years.[23] We interpret this average life expectancy in the way, that after 70 years, the constructed home has lost its value and the real estate price is solely due to the land the house has been built on.

The share of expenditures for land in the production process μ_l is set to 0.40, which represents the proportion of the value of total land to total housing wealth in Germany.[24]

The parameter ϑ represents the relative preference for consumption of housing services. We set the parameter to 0.21, fixing the share of production in the construction sector to total production less construction to 6%, which has been the average in the years from 1991 to 2011.

The share of total production used for redistribution to renting households in the baseline model we set to $\phi = 0.05$, which has been the average share of monetary benefits of territorial authorities to GDP over the period from 1991 to 2012.[25] The government share $\tau = \theta + \phi$ we set to 0.45 roughly representing the average share of government expenditure in Germany in the years from 2004 to 2013.

[20] One period is equivalent to one quarter.

[21] Data are only available every four years starting in 1998.

[22] See section (2.2). In section (4.3) we abolish this assumption and instead assume the landlords' labor share to equal the observed labor share of the top 43% of labor income earners.

[23] The German statistical office assumes an average life expectancy for residential real estate of about 74 years (Schmalwasser and Schidlowski 2006). However, it strongly depends on the object's category, varying between 40 and 95 years.

[24] We calibrate this parameter using the average square meter price for building ground in residential areas multiplied by total base area for residential buildings as proxy for total land value and divide this by the net value of residential buildings, approximating total housing wealth. Data are available for the years of 2004 and 2008 − 2011.

[25] We exclude monetary benefits of social security as the redistributive character of these payments is unclear, as e.g. pension benefits are linked to previous payments.

4 Simulation Results

In this section we report the simulation results of the two redistributive policy measures. As we are primarily interested in long run effects of the two policies, we first investigate the effects on the economy's steady state. We proceed by showing the dynamics in the economy, as these give additional insights into the effects that are driving the equilibrium allocation.

As the real estate market suffers from substantially larger frictions than markets of shorter lived consumption goods, we advise the reader to interpret the dynamic analysis with caution. Even though we incorporate the durable nature of the housing stock in the model, resulting in a delayed adjustment to the new steady state after a shock, we e.g. do not implement relatively rigid contracting between tenants and landlords or repartitioning of the housing stock into different units in the model, which might distort the transitional dynamics.

4.1 Steady state analysis

The effects of the implementation of the two policies on the steady state equilibrium are reported in table (2) in appendix B. Let us first examine an **increase in transfers to tenants**. We assume an permanent increase in transfer payments of 1%-point ($\varsigma = 0.01$), as described in section (2.4.1). As discussed, redistribution itself is assumed to take place without directly distorting the households' behavioral equations. Households are affected by the change in net wealth as well as the increase in distortionary tax rate only. Therefore we consider the distortive effects associated with redistribution via transfer payments to represent the lower end of possible distortive effects.

Given the calibration as described in section (3), the tax rate τ has to increase by 1%-point to 46% to finance the additional spending. The results of this policy simulation are in line with the literature on distortionary taxation. As labor income, which enables households to consume, is taxed while leisure is an untaxed good, an increase in the tax rate results in a reduction in the households' labor supply and this way in a reduction of total hours worked. Given this reduction in labor input, aggregate output decreases as well, by about 0.63%. This reduction in output is similar in both sectors, consumption goods and housing services. In line with the decline in construction activity housing quality decreases as well, although slightly less than construction activity.

Even though the economy seems to be affected by this tax increase almost homogeneously, the introduction of transfers affects tenants and landlords very differently. The additional transfer payment results in an increase in net wealth of tenants, who adjust their labor supply decision accordingly. The wealth increase translates into an increase in the tenants' leisure as well as consumption of goods and housing services. In contrast, landlords are hit twice. First, the tax increase distorts the households' labor supply decision. Second, landlords do not benefit from transfer payments, resulting in a reduction in net wealth due to increased taxes. The latter holds true, even if additional taxes would not have been distortionary but would have been implemented via lump sum taxes. Accordingly, landlords reduce both, their labor supply as well as their consumption. As a result, living space occupied by tenants increases by about 1.2% while that of landlords is reduced by about 1.5%. The different effects for the two household types are also reflected in households' momentary utility U_i and U_i^I. Patient households face substantial utility losses; tenants' utility on the other hand increases.

Let us now turn to an **intervention on the market for rental prices**. As described in section (2.4.2) we assume that the government sets an upper bound to square meter rents by linking rents to square meter prices of newly build homes. In the implementation in this model, the government uses the inverse of the price-to-quarterly rent ratio γ_H as policy variable. Given the baseline solution, the steady state value of the inverse of the price-to-rent ratio can be derived from combining the equations (23) and (24), $\frac{q_H}{m} = 1 - \beta(1 - \delta_H)$. Given our calibration this yields a value of approximately 0.015 for $\frac{q_H}{m}$.[26] To yield an identical increase in the welfare of tenants, compared to the transfer case, the government has to lower this ratio by about 0.0016 points and set γ_H to 0.013.[27]

There are two possibilities that would ensure that equation (17) holds with equality after a government intervention. First, house prices could increase; second, rent prices could decrease. Our simulation shows that actually both is happening in the model but to a different extent. While real house prices increase substantially, by about 10%, real rents decrease only slightly by about 0.6%.

The increase in the price of housing services also is the key in understanding the increased construction activity, which might by counter-intuitive. Let us therefore take a look at the effect of rent control on the landlord's maximization problem and the resulting price to rent ratio. Similar to the baseline scenario we can compute the price to rent ratio in steady state by combining equation (23) and equation (24). The ratio is now given by $\frac{q_H}{m} = 1 - \beta(1 - \delta_H)\frac{1-\lambda_m c \frac{\gamma_H}{\delta_H}}{1-\lambda_m c}$. Here, λ_m is the Lagrange multiplier of the additional constraint imposed by the government setting γ_H, ensuring that equation (17) does hold with equality. Now, when deciding on their investment in the housing stock, which is driving construction activity, landlords take into account that higher house prices also increase the rent they are able to charge from tenants ($m_t \sum_i H_{i,t} = q_{H,t} \sum_i I_{i,H,t} \frac{\gamma_H}{\delta_H}$). Due

[26]The model has been calibrated for quarterly data, which results in a ratio of an annual square meter rent to the square meter price of about 0.06.

[27]As discussed in section (2.4.2) we assume that the price-to-rent ration is enforceable by law, similar to already existing restrictions that link rental prices to the price level.

to the Cobb-Douglas production function an increase in construction activity increases the cost of production and this way house prices. That is why the government intervention makes investment in the housing stock relatively more attractive, driving up house prices and construction activity.

Taking a look at the different effects on the two household types, we again observe that tenants benefit from the government intervention while landlords suffer from the income loss. Accordingly, to compensate for this loss landlords increase their labor supply and decrease consumption of goods and living space. Tenants, on the other hand, increase demand for both, consumption goods and housing services, with the one for housing services being especially pronounced. Moreover, they increase their living space in square meters by roughly 0.9%, while landlords reduce their average square meter living space by about 1.1%.

We calibrate the government intervention to result in an identical increase in steady state momentary utility of tenants U_i^I in the two simulated policy alternatives. The steady state loss of momentary utility for landlords U_i is, however, substantially less pronounced in the case of an introduction of rent control in comparison to increased transfer payments.

4.2 Dynamic analysis

The dynamic analysis unveils substantial differences in the timing till the two policies take their full effect (figure 1).[28] In the case of additional transfers most variables immediately jump to values near the new steady state. Adjustments after this initial jump are more or less negligible in magnitude. This is in contrast to the introduction of rent control. In this case the convergence to the new steady state is much more gradual. While landlords suffer from a substantial utility loss when the rent control is introduced, it takes a substantial amount of time until landlords reach their new steady state level, which is well above the one of the transfer case. Tenants on the other hand face a substantially smaller momentary utility increase in the case of rent control; however, due to our calibration, the momentary utility increase in the steady state is similar to the one of transfer payments.

These differences in the evolution of households' utility can be traced back to the different pattern of real investment activity, which translates into the different evolution of the stock of housing services. In the transfer case, steady state investment slightly decreases, resulting in the housing stock to decrease as well. This way, landlords and tenants utilize the excess housing stock till the stock of housing services has converged to the new steady state level. That is why momentary utility for tenants is overshooting and further decreasing over time for landlords. However, as the reduction in investment

[28]We compute the transitional dynamics of the model using Dynare (Juillard 2001).

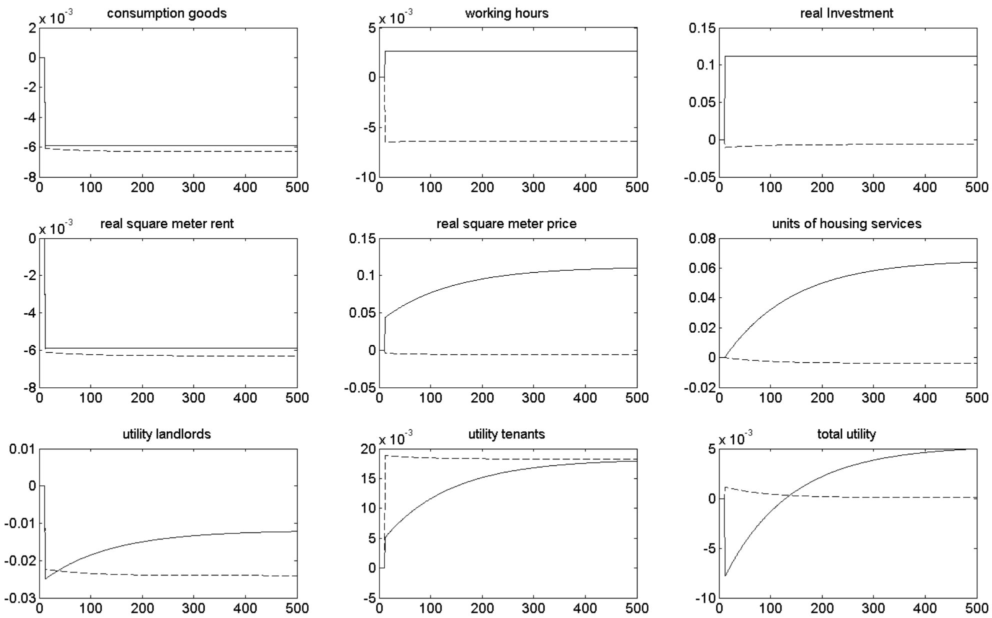

Figure 1: Impulse response of key variables to an introduction of rent controls (solid line) and tax financed transfer payments (dashed line) in period 10.

activity is very small, both household types jump to utility levels in the neighborhood of their new steady state.

In the case of rent control the new steady state value for real investment is well above the former steady state, resulting in a substantive period of time till the new steady state level for housing services is reached. During this time, utility for the two household types is well below their new steady state. A substantial portion of resources is required to reach the new steady state level of housing services. This only gradual increase in housing quality also results in the slow adjustment of real square meter prices of properties.

4.3 Robustness Check

Let us now turn to the case where tenants do not only differ in their time preference, but also in the labor share the individual household receives. Instead of the labor share mirroring the differences in the population size ($\alpha = \rho$), we assume that households with housing wealth are also the ones with higher labor income. To calibrate the labor share of landlords and tenants we make use of the FAST data by the German Statistical Office (Schwabbacher 2013). This dataset is a representative sample of all individuals that are subject to income taxes in Germany in the year 2007. According to this dataset, the top 43% of income earners received about 84% of labor income in the economy. That is why we calibrate α to 0.8 in this alternative scenario to replicate such an income distribution in our model.

In order to keep the calibration in all other aspects similar to the baseline calibration, we also have to recalibrate the parameter χ (table B). To keep total hours worked in the economy $(n_c + n_h + n_c^I + n_h^I)$ at 14.25, representing 57 Bill. hours worked per year, χ now has to equal 1.62×10^{-07}. All other parameters remain unchanged.

4.3.1 Simulation Results in the Alternative Calibration

We report the results of the simulations given the alternative parameter calibration in figure (3) in appendix C. However, the results are very similar to the ones given the baseline calibration. Let us first examine the effects on the allocation in steady state. Again, an increase in the tax rate increases the tax wedge making leisure relatively more attractive and this way reducing total output. As tenants receive additional transfers, they increase their consumption expenditures as well as their living space. Given tenants' substantially lower labor share, there are two differences in comparison to the results in section (4.1). First, the difference in utility between the two household types is substantially more pronounced. Second, a one percentage point increase in transfer payments now has a significantly larger effect on tenants' utility, which is intuitive given the convex nature of the utility function. Tenants momentary steady state utility increases in the alternative specification by 0.0725 points in absolute terms, compared to 0.0183 points in the baseline calibration (section 4.1).

Turning to the introduction of rent control, the government's intervention in the price setting mechanism at the rental market has to be substantially more pronounced to replicate the tenants' higher welfare increase. While similar to section (4.1), the annual rent to price relation is at 0.06 as $\frac{q_H}{m} = 1 - \beta(1 - \delta_H)$ is independent of the labor share α, this relation has to decrease to 0.04 to yield a similar utility increase for tenants as in the case of additional transfer payments. The qualitative results seem to be completely robust to the change in the calibration. Rent control, linking rent to house prices, seems to result in higher house prices, as landlords take into account that higher house prices also increase rents they are able to charge. This way construction activity also increases. The quantitative results do of course differ as the government intervention has to be more distortionary than in the baseline scenario, but tthe result that landlords suffer less in steady state given rent control does seem to hold up.

With respect to the transitional dynamics (figure 2 in appendix C), there are also no remarkable differences to the baseline ones as reported in section (4.2). In the case of transfer payments, households seem to benefit from the excess housing stock, as investment activity slightly declines in steady state. Given the rent control case, households have to invest resources in the buildup of the housing stock. That is why the advantageousness of rent control is fully effective only after the buildup of the additional housing stock.

5 Conclusion

In this paper we investigate the effect of the implementation of rent control on equilibrium allocation and the welfare of households in a general equilibrium model. There are two types of households in the model, landlords and tenants, which differ in terms of their time preference. Due to this difference, landlords end up owning the housing stock, while tenants do not own their place of residence but rent housing services from landlords. We calibrate the model to fit key features of the German economy.

Assuming that the government has the aim of increasing utility for the less wealthy households, which typically are tenants, we compare two different policies. First, an increase in the tax rate to increase the volume of transfer payments to tenants. Second, an intervention in the rental market for housing services by linking real rents to prices of newly build homes. In line with the literature both measures have distortionary effects. In steady state, utility of tenants increases in both cases while the one of landlords decreases. Comparing the two policies we find that if both policies yield identical utility increases for tenants in steady state, the decrease in the utility for landlords is substantially smaller in the case of an introduction of rent control.

Examining the transitional dynamics we show that the introduction of rent control, as modeled in this paper, has stronger distortionary effects on the steady state level of housing services, implying a slower convergence to the new steady state in comparison to the case of additional transfers.

Given these results the implementation of rent control Pareto dominates a raise in tax rates to increase redistributive transfer payments in steady state. This holds true even if redistribution takes place via lump sum transfers, which do not have distortionary effects itself. Even though our model is highly simplified, we abstract from capital investments as well as search frictions in the housing market, we think our results suggest that given the positive redistributive effects, rent control might not be as harmful as widely perceived and further research on this topic should be done.

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A Model Equations

The baseline model can be described by the following set of equations with $\lambda_{m,t} = 0$ and $\varsigma_t = 0$:

$$1 = \lambda_t c_t \tag{18}$$

$$\vartheta c_t = m_t h_t \tag{19}$$

$$\chi \left(\frac{n_{c,t} + n_{h,t}}{\rho P} \right)^{\eta} \frac{c_t}{\rho P} = (1 - \tau_t) w_{c,t} \tag{20}$$

$$\chi \left(\frac{n_{c,t} + n_{h,t}}{\rho P} \right)^{\eta} \frac{c_t}{\rho P} = (1 - \tau_t) w_{h,t} \tag{21}$$

$$\lambda_t = \beta \lambda_{t+1} R_t \tag{22}$$

$$q_{H,t} \left(1 - \frac{\lambda_{m,t}}{\lambda_t} \frac{\gamma_H}{\delta_H} \right) = \frac{\lambda_{h,t}}{\lambda_t} \tag{23}$$

$$\frac{\lambda_{h,t}}{\lambda_t} = \frac{1 - \delta_H}{R_t} \frac{\lambda_{h,t+1}}{\lambda_{t+1}} + m_t \left(1 - \frac{\lambda_{m,t}}{\lambda_t} \right) \tag{24}$$

$$(1 - \tau_t) q_{l,t} = \frac{\lambda_{l,t}}{\lambda_t} \tag{25}$$

$$\vartheta c_t^I = m_t h_t^I \tag{26}$$

$$\chi \left(\frac{n_{c,t}^I + n_{h,t}^I}{(1-\rho) P} \right)^{\eta} \frac{c_t^I}{(1-\rho) P} = (1 - \tau_t) w_{c,t}^I \tag{27}$$

$$\chi \left(\frac{n_{c,t}^I + n_{h,t}^I}{(1-\rho) P} \right)^{\eta} \frac{c_t^I}{(1-\rho) P} = (1 - \tau_t) w_{h,t}^I \tag{28}$$

$$\alpha Y_t = w_{c,t} n_{c,t} \tag{29}$$

$$(1 - \alpha) Y_t = w_{c,t}^I n_{c,t}^I \tag{30}$$

$$q_{H,t} \alpha (1 - \mu_l) I_{H,t} = w_{h,t} n_{h,t} \tag{31}$$

$$q_{H,t} (1 - \alpha)(1 - \mu_l) I_{H,t} = w_{h,t}^I n_{h,t}^I \tag{32}$$

$$q_{H,t} \mu_l I_{H,t} = q_{l,t} I_{l,t} \tag{33}$$

$$c_t + m_t h_t + q_{H,t} I_{H,t} = (1 - \tau_t)(w_{c,t} n_{c,t} + w_{h,t} n_{h,t} + q_{l,t} I_{l,t}) + m_t H_t \tag{34}$$

$$H_t = (1 - \delta_H) H_{t-1} + I_{H,t} \tag{35}$$

$$I_{l,t} = \delta_H L_{t-1} \tag{36}$$

$$c_t^I + m_t h_t^I = (1 - \tau_t)(w_{c,t}^I n_{c,t}^I + w_{h,t}^I n_{h,t}^I) + (\phi + \varsigma_t)(Y_t + q_{H,t} I_{H,t}) \tag{37}$$

$$Y_t = (n_{c,t})^{\alpha}\ (n^I_{c,t})^{1-\alpha} \tag{38}$$

$$I_{H,t} = ((n_{h,t})^{\alpha}\ (n^I_{h,t})^{1-\alpha})^{1-\mu_l}\ (I_{l,t})^{\mu_l} \tag{39}$$

$$H_t = h_t + h^I_t \tag{40}$$

$$L_t = L_{t-1} \tag{41}$$

$$\tau_t = \theta + \phi + \varsigma_t \tag{42}$$

In case of an increase in lump sum transfers to renting households the model can be described by the system of equations (18) - (42), $\lambda_{m,t} = 0$ and an exogenous value for ς_t.

In case of the introduction of rent controls the model consists of equations (18) - (42), $\varsigma_t = 0$ and the additional equation

$$m_t \frac{H_t}{L_t} = q_{H,t} \frac{I_{H,t}}{I_{l,t}} \gamma_H\ . \tag{43}$$

B Baseline Calibration

Table 1: Calibrated Parameters

Parameter	Parameter Value	Variable	Interpretation	Variable Value
			Baseline Calibration	
β	0.9925	$4 \times R - 1$	Annual real interest rate	3%
ϑ	0.2076	$\frac{q_H I_h}{Y}$	Construction to total production less construction	0.06
χ	1.75×10^{-7}	$4 \times (n_c + n_h + n_c^I + n_h^I)$	Total hours worked (in billion)	57
η	2	$\frac{1}{\eta}$	Frisch elasticity of labor supply	0.5
ρ	0.43	ρ	Population share with housing wealth	0.43
α	0.43	α	Labor share of households with housing wealth	0.43
μ_l	0.4	$\frac{q_l l}{q_H H}$	Value of land to housing wealth	0.4
δ_H	0.0075	$\frac{1}{4} - \frac{1}{4}\sqrt[70]{\frac{q_l}{q_H H}}$	Annual housing stock depreciation rate	3%
θ	0.40	τ	Government share of GDP	0.45
		ϕ	Redistribution as share of GDP	5%
		P	Total population	0.08
		L	Total living space (in billion sqm)	3.364
			Changes in the Alternative Calibration	
χ	1.62×10^{-7}	$4 \times (n_c + n_h + n_c^I + n_h^I)$	Total hours worked (in billion)	57
α	0.8	α	Labor share of households with housing wealth	0.8

C Simulation Results

Table 2: Steady State Comparison

Variabel	Parameter	Baseline	Redistribution	Rent Controls
Total Production	$Y + q_h I_h$	7.36	-0.63%	0.52%
Total consumption	$c + c^I$	4.00	-0.63%	-0.59%
Consumption landlords	c	1.83	-2.10%	-1.69%
Consumption tenants	c^I	2.17	0.60%	0.31%
Total construction	$q_h I_h$	0.42	-0.63%	10.06%
Total hours worked	$n_c + n_h + n_c^I + n_h^I$	14.25	-0.64%	0.27%
by landlords	$n_c + n_h$	6.00	-0.12%	0.65%
by tenants	$n_c^I + n_h^I$	8.25	-1.02%	-0.01%
Real house price (sqm)	$q_h \frac{H}{L}$	16.51	-0.63%	10.06%
Real rent (sqm)	$m \frac{H}{L}$	0.25	-0.63%	-0.59%
Land Price	q_l	6.61	-0.63%	10.06%
Housing quality	H	3.96	-0.38%	6.16%
Living space per landlord	$\frac{h}{\rho P} \frac{H}{l}$	44.68	-1.48%	-1.07%
Living space per tenant	$\frac{h^I}{(1-\rho)P} \frac{H}{l}$	40.07	1.23%	0.90%
Current period utility landlord	U_i	4.74	-0.0240	-0.0119
Current period utility tenant	U_i^I	4.57	0.0183	0.0183

Table 3: Steady State Comparison, Alternative Calibration

Variabel	Parameter	Baseline	Redistribution	Rent Controls
Total Production	$Y + q_h I_h$	6.82	-0.51%	2.26%
Total consumption	$c + c^I$	3.71	-0.51%	-2.35%
Consumption landlords	c	2.82	-2.11%	-3.66%
Consumption tenants	c^I	0.89	4.57%	1.58%
Total construction	$q_h I_h$	0.39	-0.51%	31.74%
Total hours worked	$n_c + n_h + n_c^I + n_h^I$	14.25	-1.27%	0.67%
by landlords	$n_c + n_h$	6.40	-0.07%	1.64%
by tenants	$n_c^I + n_h^I$	7.85	-2.25%	-0.11%
Real house price (sqm)	$q_h \frac{H}{L}$	15.31	-0.51%	31.74%
Real rent (sqm)	$m \frac{H}{L}$	0.23	-0.51%	-2.35%
Land Price	q_l	6.12	-0.51%	31.74%
Housing quality	H	3.78	-0.31%	20.48%
Living space per landlord	$\frac{h}{\rho P} \frac{H}{l}$	74.32	-1.61%	-1.26%
Living space per tenant	$\frac{h^I}{(1-\rho)P} \frac{H}{l}$	17.71	4.86%	3.84%
Current period utility landlord	U_i	5.23	-0.0247	-0.0083
Current period utility tenant	U_i^I	3.57	0.0725	0.0725

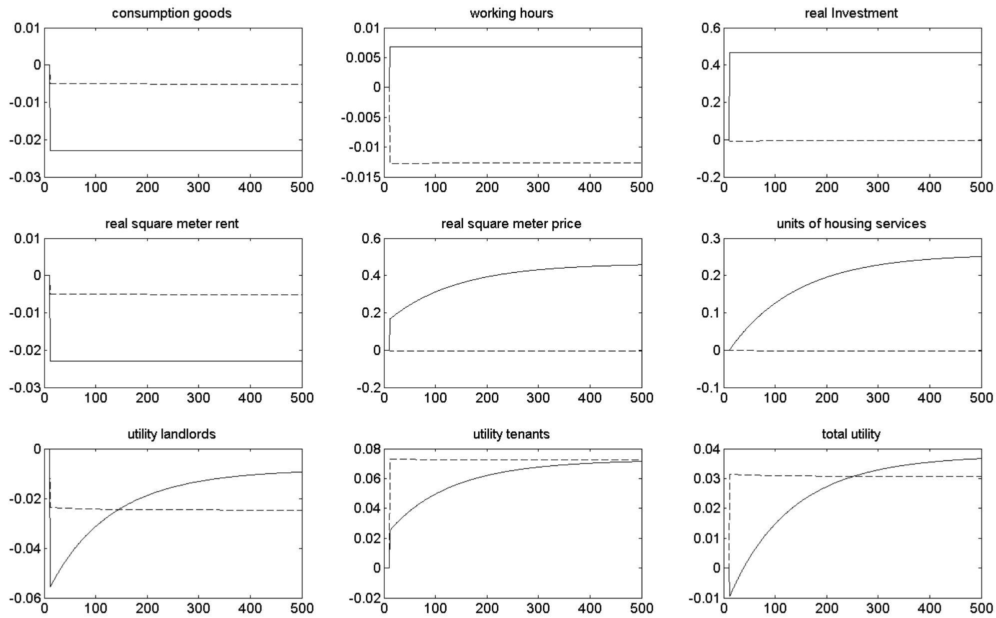

Figure 2: Impulse response of key variables to an introduction of rent controls (solid line) and tax financed transfer payments (dashed line) in period 10, alternative calibration.